3rd Integrated CNS Technologies Conference & Workshop

General Aviation Aircraft Data Communications Analysis Using a Web-Based Tool

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Outline

- **Background**
- **SATS communications requirements analysis process**
- **Future Aviation Subnetwork Traffic Emulator for CNS (FASTE-CNS) tool**
- **SATS communications analysis using FASTE-CNS**
- **Summary**

Background

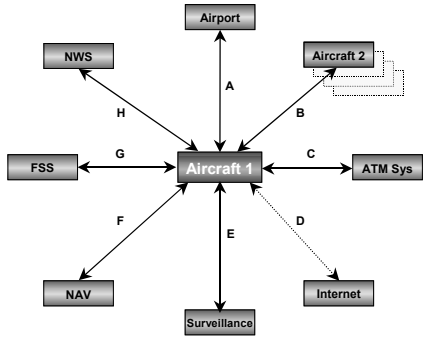
- **Background: The Small Aircraft Transportation System (SATS) program proposed using an Airborne Internet (AI) for aircraft data communications.**
- **Problem: Determine the communications load that the AI needed to support.**
  - **Analysis to determine the AI load was performed using spreadsheet models.**
  - **First, looked at the communications needs for a single aircraft.**
  - **Then, looked at the communications load within a 50 nm radius of a SATS airfield. Assumed 100 aircraft in the region.**
- **GRC's FASTE-CNS lets a researcher perform the same analysis via the Internet using a browser.**

SATS AI Analysis Process

Operational Services (based on Operational Concepts)

Ref #	SATS User Services	Functional Capability
1	Flight Service	File flight plans and amendments. Process flight plans and amendments. Provide information for flight plans. Obtain in-flight or pre-flight weather and NAS status (NOTAMs) advisories. (*Near real time and forecast, tactical and strategic*) Obtain in-flight or pre-flight traffic advisories. (*Existing tactical and strategic*) Obtain in-flight NAS status advisories – current and scheduled.
2	Air Traffic Service	Provide separation of aircraft during ground operations. Provide separation of in-flight IFR aircraft. Avoid potential hazards and collisions. Maintain minimum distance from Special Use Airspace (SUA). Monitor flight progress. Enable in-flight sequencing, spacing, and flow management for SATS aircraft. Obtain pre-flight runway, taxi sequence, and movement restrictions. Project aircraft in-flight position and identify potential conflicts. Provide data to support managing use of SUA.
3	Emergency and Alerting Service	Provide emergency assistance and alerts. (*For downed or troubled aircraft*) Support search and rescue.
4	Self-Separation and Sequencing Service	Provide data to ensure proper separation to avoid potential hazards and collisions. Provide data to support VFR and IFR traffic separation. Provide data to monitor flight progress. Provide self-separation in NAS.
5	Navigation Service	Provide airborne navigation guidance.
6	Pilot/Aircraft Information Service	Provide information concerning the flight. Enable separation of in-flight IFR aircraft. Enable in-flight sequencing and spacing for SATS aircraft. Provide aircraft in-flight position and identify potential conflicts.
7	Aircraft and Travel Service	Provide information about airport services. Notification to owner/operator about change in aircraft availability. Notification to owner/operator about aircraft maintenance issues. Provide other travel related information.
8	Public Information Exchange Service	Provide in-flight entertainment. Provide public communications including email and web browsing.

Entity and services relationships Reference Model



Services allocated to system entities

State	Purpose	Functions	A/C 1	A/C 2	Int	Surv	NAV	FSS	NWS	ATM Sys	Airport
2005	Provide data for tracking aircraft on the ground. Provide data for tracking an aircraft enroute Support safe separation between participating traffic and airspace.	Provide data to ensure proper separation to avoid potential hazards and collisions. Provide data to support VFR and IFR traffic separation. Provide data to monitor flight progress.	X			X					

Information Exchange Data Objects allocated by service / functional processes (data flows)

State	Purpose	Functions	FPU	WX	AS	MC	NAV	ASI	PE	PIE
2005	Provide data for tracking aircraft on the ground. Provide data for tracking an aircraft enroute Support safe separation between participating traffic and airspace.	Provide data to ensure proper separation to avoid potential hazards and collisions. Provide data to support VFR and IFR traffic separation. Provide data to monitor flight progress.			X					

Information Exchange Needs (communications requirements)

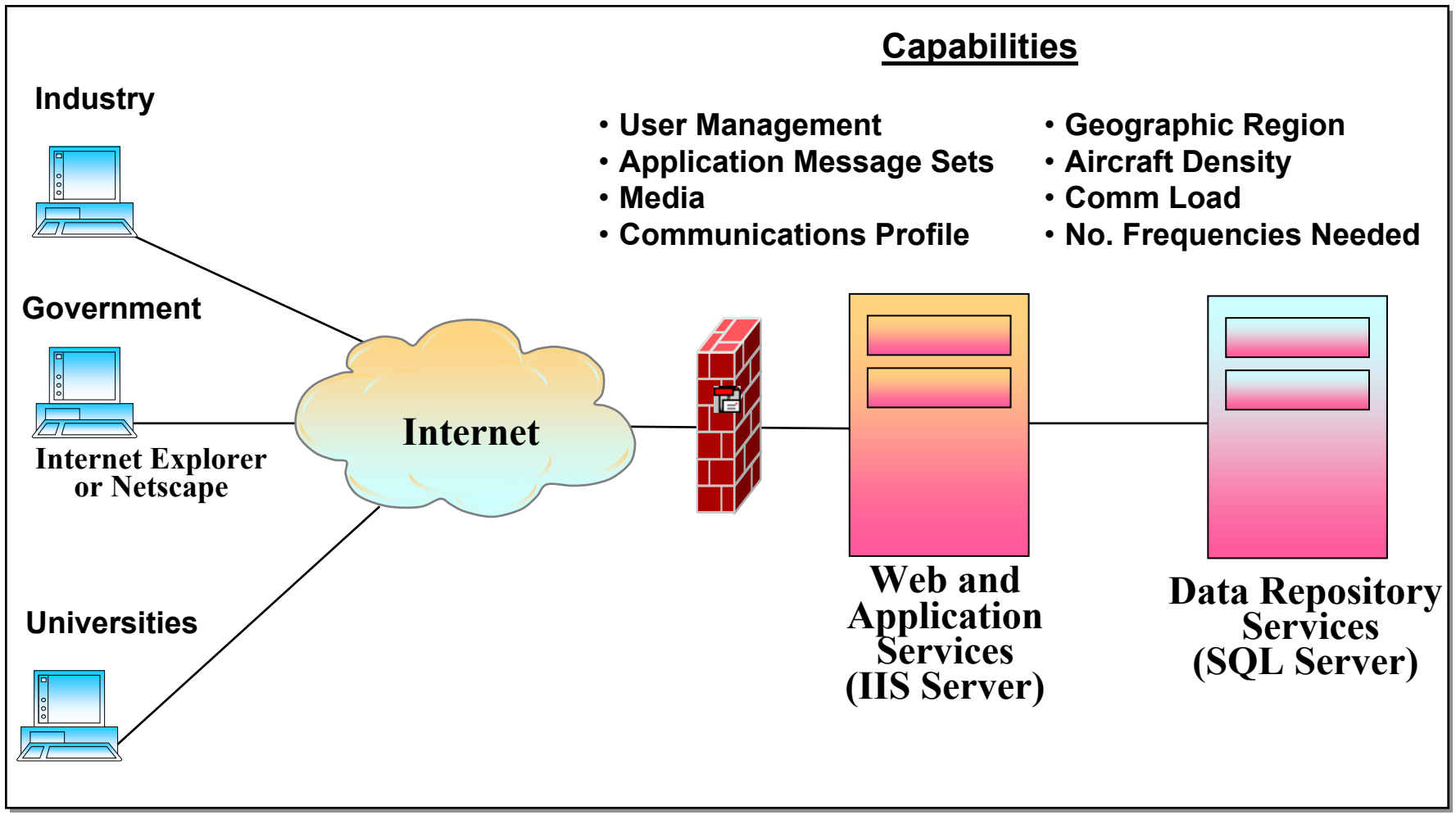
Information Exchange – (IE Object) Airspace Situation (AS) Applicable Interface: (Entity-to-Entity) E	Type: G/A Integrity (Error Rate): High Information Unit Size (Min, Max, Avg): 0.2 Kb, 13 Kb, 11 Kb Frequency of Occurrence: 5 seconds Acceptable Delay: 5 seconds Authentication: No Priority: Medium Retransmission Required: No Suitable for Addressed Communications: No Suitable for Broadcast: Yes Suitable for Multicast: Yes

+ Loading

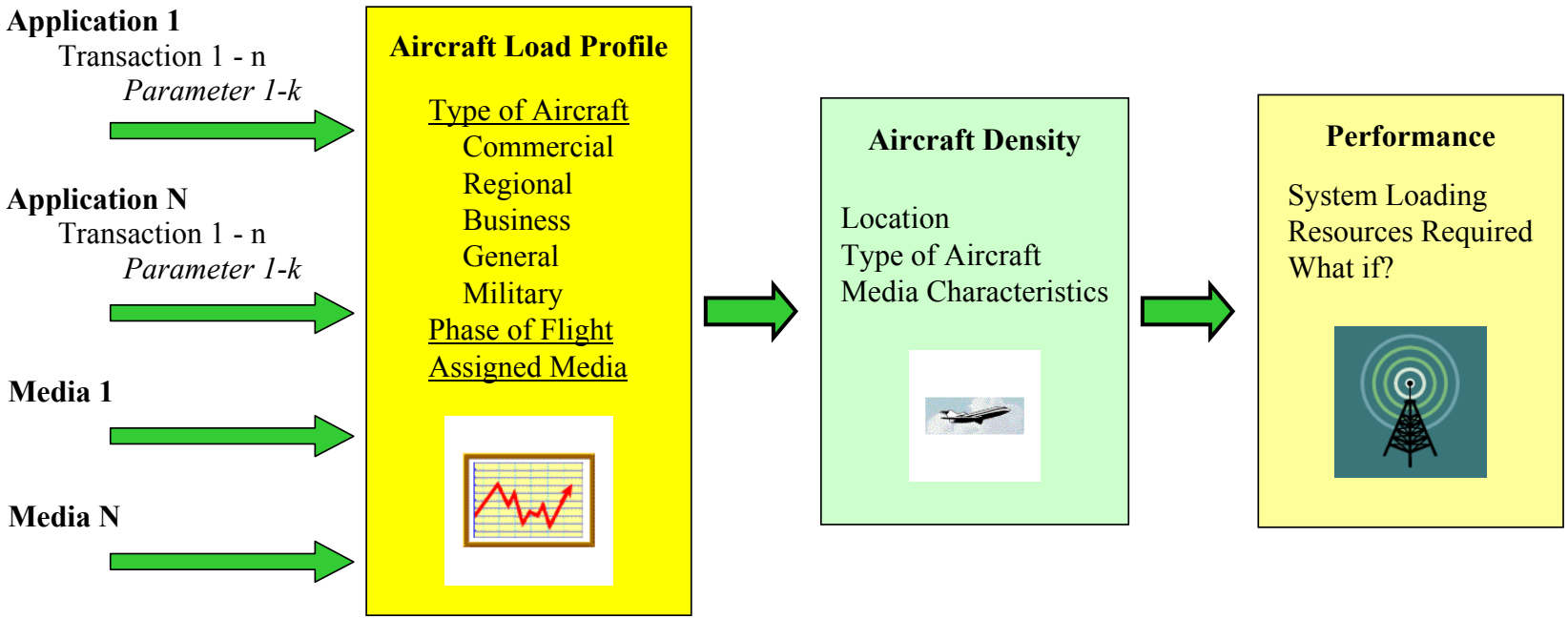
What is FASTE-CNS?

- **GRC dynamic communications estimating tool**
- **Provides a means to define and assess the communications traffic loading associated with aeronautical related applications.**
- **Accessible via the Internet**
- **Supports collaborative research**

FASTE-CNS System Architecture



Generic Loading Analysis



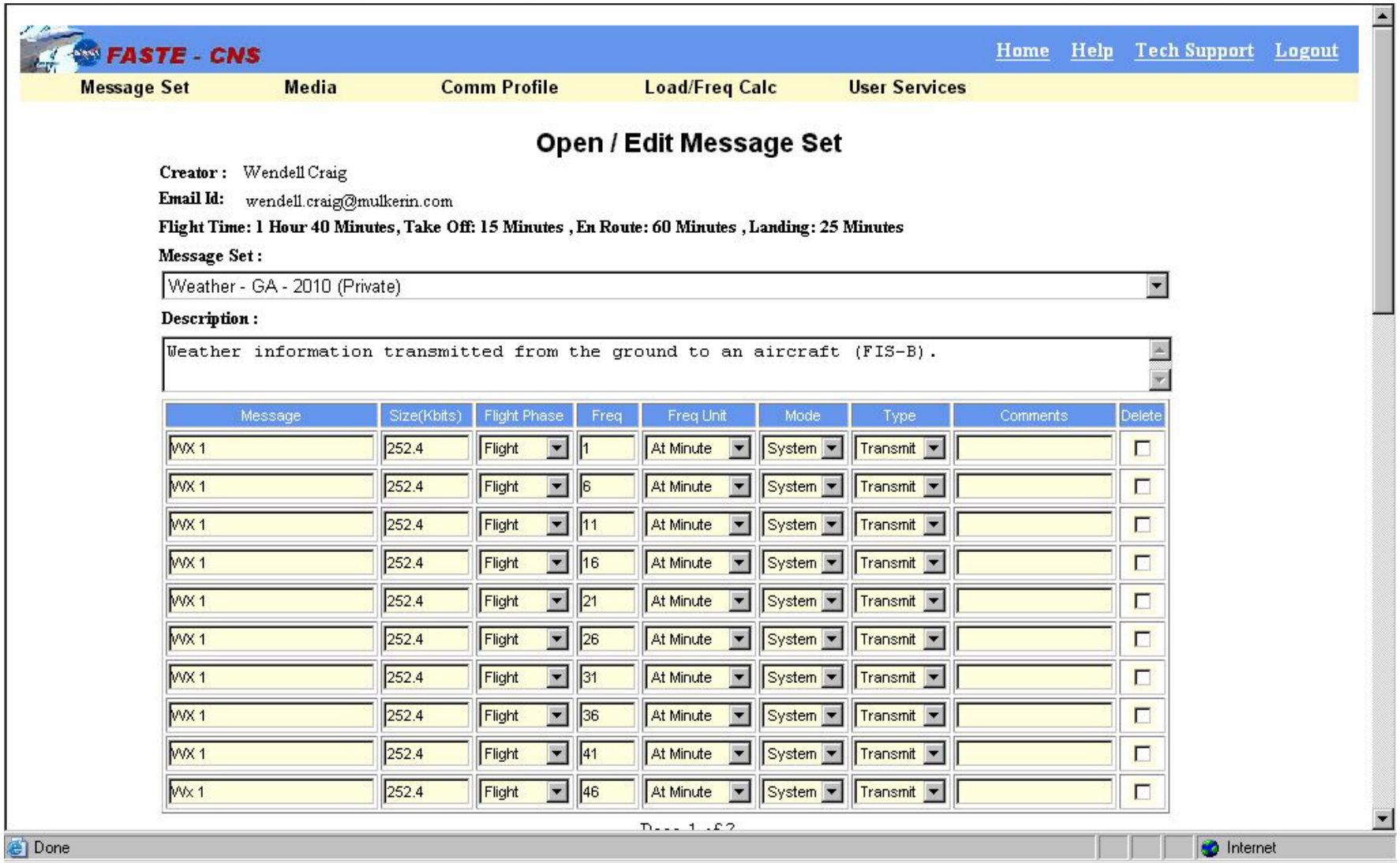
Process Modeled by FASTE-CNS

AI Objects = Application Message Sets

SATS analysis process defined information exchange objects needed to perform the operational service functions. Objects equate to message sets in our FASTE-CNS analysis.

Ref #	SATS Information Exchange Object	Description of Process/Data
1	Flight Planning and Use (FPU)	Submission and processing of original or revised flight plans.
2	Weather (WX)	Collection and exchange of weather data both forecast and current (FIS-B like)
3	Airspace Situation (AS)	Information to enable a common situational awareness (ADS-B /TIS-B like).
4	Maneuver & Control (MC)	Near real time exchange of data to direct or implement the maneuvering of an aircraft (CPDLC like).
5	Navigation Information (NAV)	Information to provide airborne and surface navigation guidance.
6	Aviation System Information (ASI)	Information regarding the current status, use or readiness of the system entities.
7	Pilot/Aircraft Information Exchange (PAE)	Pilot-to-pilot or aircraft-to-aircraft exchange of flight information.
8	Aircraft & Travel (AT)	Exchange of aircraft status and other travel related information.
9	Tropospheric Airborne Meteorological Data Reporting (TAMDAR)	Meteorological conditions, including moisture, temperature and winds gathered by aircraft sensors.

Weather Message Set



Message	Size(Kbits)	Flight Phase	Freq	Freq Unit	Mode	Type	Comments	Delete
WX 1	252.4	Flight	1	At Minute	System	Transmit		
WX 1	252.4	Flight	6	At Minute	System	Transmit		
WX 1	252.4	Flight	11	At Minute	System	Transmit		
WX 1	252.4	Flight	16	At Minute	System	Transmit		
WX 1	252.4	Flight	21	At Minute	System	Transmit		
WX 1	252.4	Flight	26	At Minute	System	Transmit		
WX 1	252.4	Flight	31	At Minute	System	Transmit		
WX 1	252.4	Flight	36	At Minute	System	Transmit		
WX 1	252.4	Flight	41	At Minute	System	Transmit		
Wx 1	252.4	Flight	46	At Minute	System	Transmit		

Communications Media

- **Media used in SATS AI was called VDL Mode SATS.**
- **2 parameters must be entered for communications media.**
  - **Range of the radio in miles: 200**
  - **Capacity of the media in the number of Kbps that a single frequency can support: 19.2 Kbps.**

Communications Profile

Open / Edit Comm Profile

Creator : Wendell Craig

Email Id : wendell.craig@mulkerin.com

Comm Profile :

GA Aircraft (with TAMDAR) - 2010 (Private)

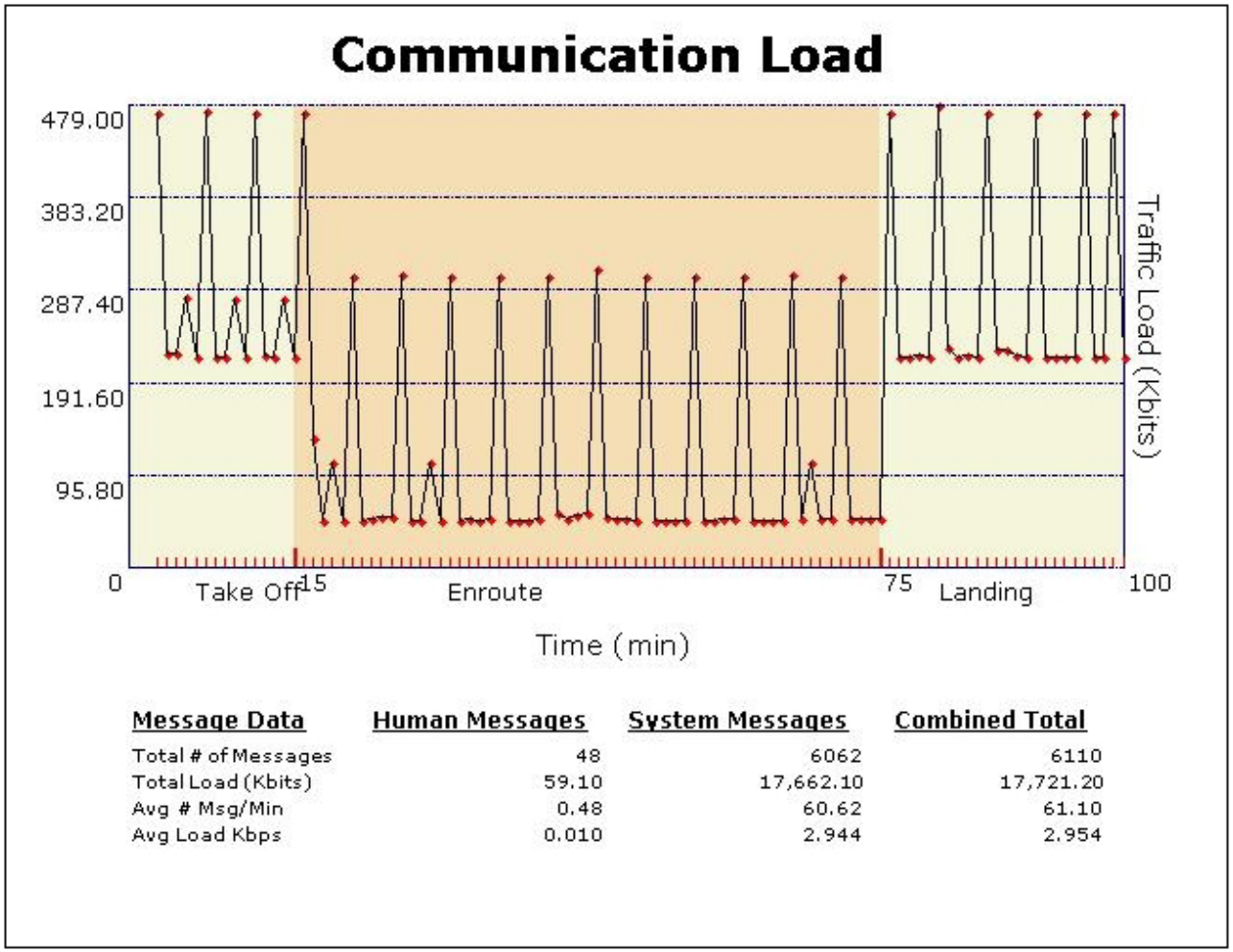
Description :

The data communications profile for a general aviation aircraft in 2010. Some of the datalink capabilities will have been developed as part of the Airborne Internet concept.

Message Set	Media	Delete
Flight Planning & Use (FPU) SATS AI (Private)	VDL SATS (Private)	☐
Maneuver & Ctrl (MC) SATS AI (Private)	VDL SATS (Private)	☐
Aviation Sys Info (ASI) SATS AI (Private)	VDL SATS (Private)	☐
Aircraft & Travel (AT) SATS AI (Private)	VDL SATS (Private)	☐
Pilot/Aircraft Info Exch (PAE) SATS AI (Private)	VDL SATS (Private)	☐
Airspace Situation (AS) SATS AI (Private)	VDL SATS (Private)	☐
Navigation Information (NAV) SATS AI AC (Private)	VDL SATS (Private)	☐
Weather (WX) SATS AI - A/C (Private)	VDL SATS (Private)	☐
TAMDAR SATS AI (Private)	VDL SATS (Private)	☐
		☐

Communications Profile Report

Media Type : All

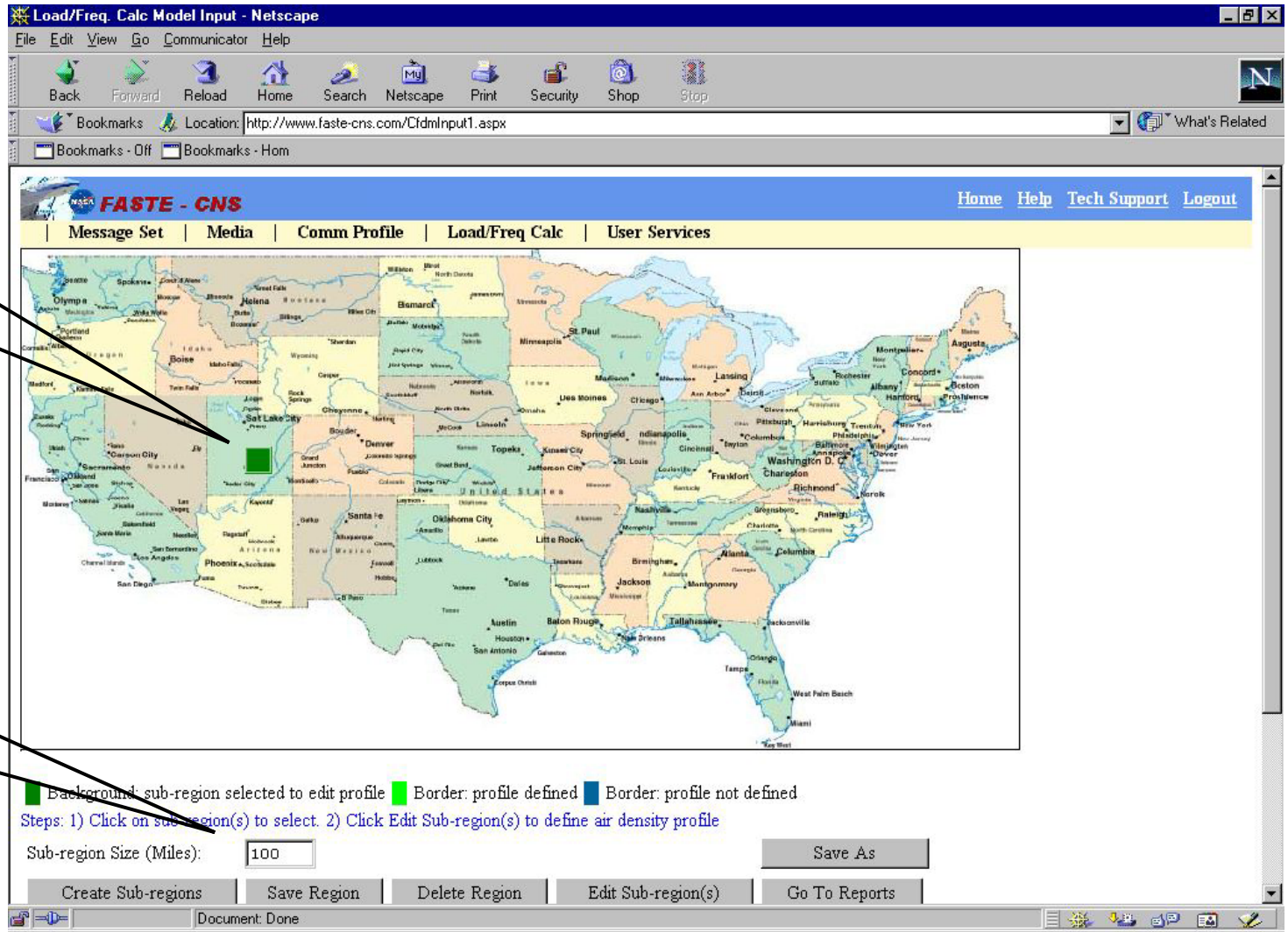


Message Data	Human Messages	System Messages	Combined Total
Total # of Messages	48	6062	6110
Total Load (Kbits)	59.10	17,662.10	17,721.20
Avg # Msg/Min	0.48	60.62	61.10
Avg Load Kbps	0.010	2.944	2.954

Adding Aircraft Density to Analysis

- **FASTE-CNS assesses the communications impact of multiple aircraft operating in the same geographic region.**
- **SATS analysis examined the communications load generated by 100 aircraft within 50 miles of a SATS AI equipped airfield.**
- **Three communications profiles used.**
  - **Two for aircraft. Identical except one contained TAMDAR message set.**
    - **25 aircraft - with TAMDAR message set**
    - **75 aircraft – without TAMDAR message set**
  - **Ground station communications profile used for all message sets broadcast from the ground.**

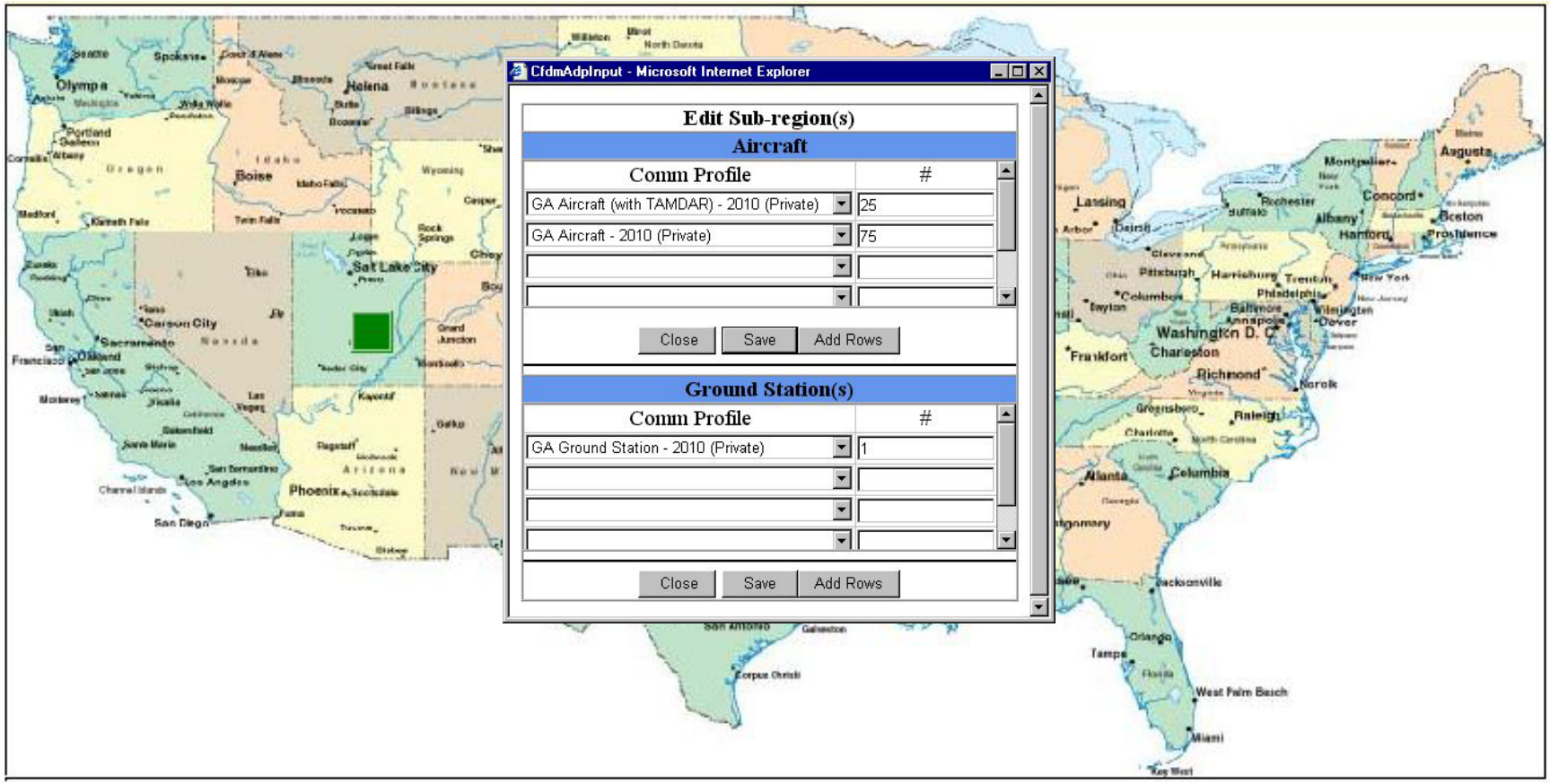
Define Region



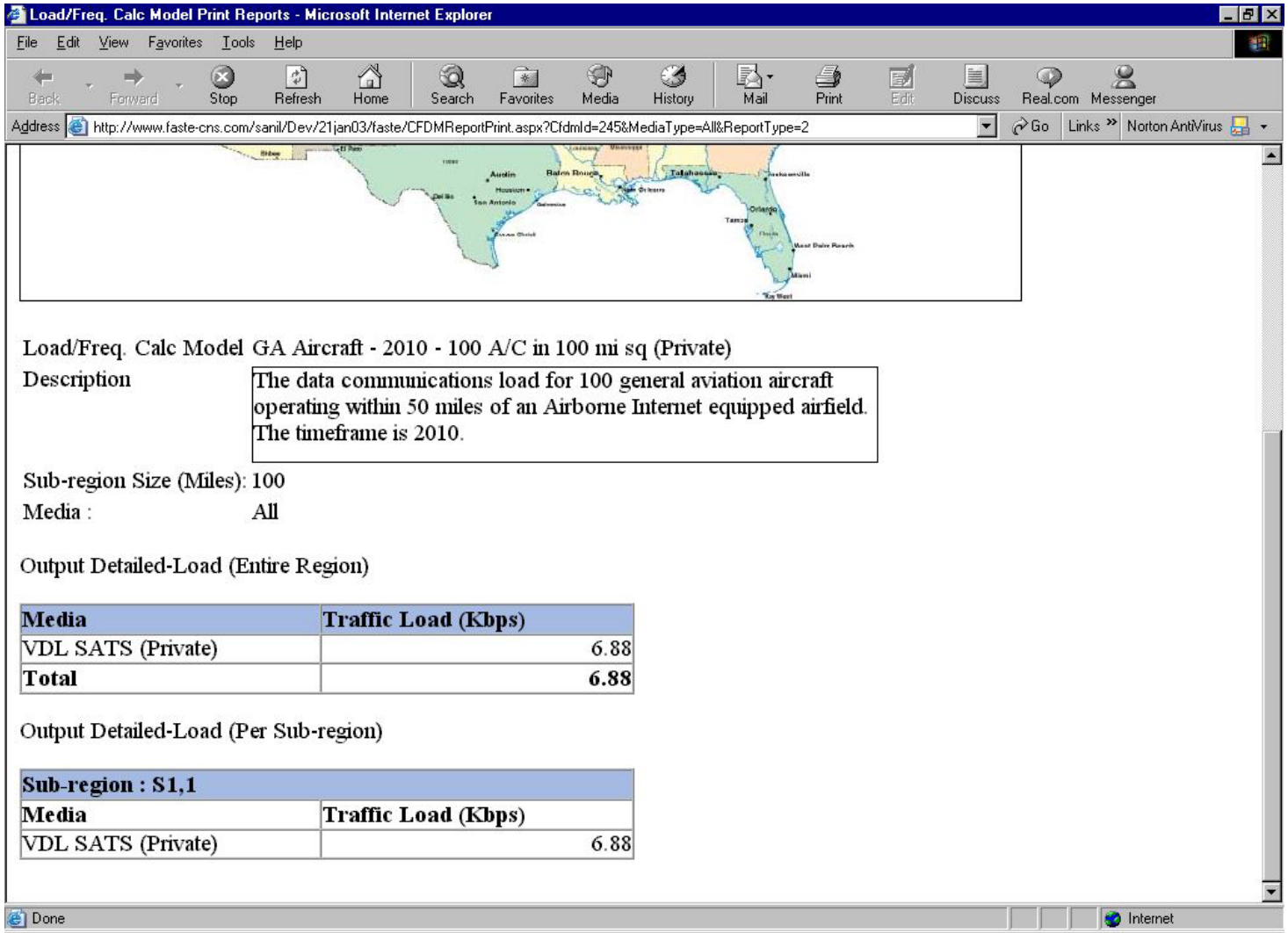
SATS Airfield Region

Enter Size of Region

Assigning Aircraft to Region



AI Communications Load



Summary

- **FASTE-CNS provides an Internet accessible capability for modeling aviation related communications.**
- **FASTE-CNS can be used to answer these questions:**
  - **What is the communications traffic load (by media) that a single aircraft would experience?**
  - **What is the communications load (by media) that would occur in a geographic region populated by multiple aircraft with different communications profiles?**
  - **What is the number of frequencies for each media needed to support the communications load within the region?**

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